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The impact of automation on student's career decision

Muhammad Hizkil Imran
Embry Riddle Aeronautical University, hizkilm@my.erau.edu

Arshveen Ramesh
Embry Riddle Aeronautical University

T Rudran
Embry Riddle Aeronautical University

Module 9: Final Research Proposal

Arshveen Ramesh

T Rudran

Muhammad Hizkil Bin Imran

Embry-Riddle Aeronautical University

Abstract

We study the impact of automation on employment and students' career paths, by obtaining credible datasets from the Government of Singapore. The manufacturing and construction sectors were the most affected industries over the last 15 years. Along with the limited studies, we propose a survey to quantify and analyse students' views on automation. The shift in employment rate in various sectors due to automation was found to be a contributing factor for students' career decisions. Based on our findings, we observed that more students are acknowledging the impact of automation and finding the need for job securities and opportunities by undertaking Engineering and Information Technology (IT) related courses.

Introduction

Technology or machines are known to be replacing humans. Artificial Intelligence (AI) is also suggested to outpace mankind. Manual labour jobs or low-skilled workers are at risk of being replaced by technologies as robots and machines are designed to accomplish repetitive tasks such as production and manufacturing efficiently and accurately. Although millions of jobs will be replaced by technology and robots, it is also important to note that there are new categories of jobs that will be created rather than destroyed due to the implementation of AI and robots. Innovation does not always equate to the extinction of jobs where workers are eventually replaced by new ones. Technology can be a complementary force in the workplace.

With that being said, technology has changed the education landscape in general. In particular, this research paper will be focusing on students as they are the future of the workforce and this issue of automation and job loss or gain is ultimately a question for the future. The objective of this paper is to evaluate the impact of automation and the future job prospects it will encompass, thus finding out if students are taking the necessary actions to learn and adapt to the future of technology incorporated jobs. This phenomenon has affected how students think and decide on their careers. Adaptability is the key to survival for students in this current generation. Instead of changing their career path due to fear of being replaced by automation, students and institutions are adapting to the current change of technological advancement. Technology has affected knowledge such as medicine, education, business communication and professional services in an obvious way however technology has also created new categories of jobs hence, increasing employment over-time in a less obvious way.

Literature Review

The Negative Impacts of Automation

Ever since the creation of the first robot in the early 1900s, automation has revolutionised the job market. Not only does it significantly influence the job sectors, but it also impacts a wide range of industries negatively as it eradicates jobs. According to a study conducted by Hawksworth, Berriman and Goel (2018), after categorising the various sectors into transport, financial services, health and all other sectors, their findings suggested that jobs pertaining to the financial sectors are extremely vulnerable to automation in the short term. Furthermore, jobs related to the transportation sector are at risk in the long run. For instance, in the transportation industry, as the introduction of self-driving cars, trains and aircraft is imminent, it will only be a matter of time before these jobs are taken over by automation. However, the article also added that their studies are based on estimates primarily on the technical feasibility of automation. In reality, the actual extent of automation may increase or decrease, which is dependent on the growth of the economy.

Although displacing jobs from the workforce is perceived negatively towards employees, establishments and businesses are thriving with the integration of automation. The introduction of automation in a business model increases operational efficiency. Robots can perform the work of three to five people, depending on the task. Automation has the ability to increase its production output (Productivity Inc, n.d.). Companies with strategies and ideas can penetrate the various industries instantaneously with no disruption to existing processes. In essence, the adoption of automation saves time and operational cost for organisations looking to increase their profit margins and Return of Investments (ROI).

Low skilled workers. In recent times, studies have shown that low-skilled jobs are certainly more vulnerable to automation. According to economist Acemoglu and Restrepo (2019), a study had been conducted to show the average displacement and reinstatement of jobs within the various industries. Between 1947 to 1987, the displacement level of jobs ranged around 17 percent and the average reinstatement of jobs varied approximately 19 percent. Subsequently, recent findings suggest that from 1987 to 2016 the displacement fluctuated around 16 percent; however, the reinstatement was only at 10 percent. Additionally, Acemoglu and Restrepo indicated that technology tends to benefit the high-skilled workers more than low-skilled workers. For example, a highly-skilled engineer utilises software or system to assist in completing a task, comparatively to a low-skilled worker who lacks synergy with new technology. In this case, the engineer will be perceived as productive and valuable, hence, maintaining their jobs. Essentially, this research paper shows a certain degree of negative impact of automation on low-skilled workers.

Need to reskill. With employees having an arduous time competing with automation, more and more workers are looking to reskill and upgrade themselves. A study by Chui and Lund (2018) suggests that millions of people are in need to acquire new skills due to the nature of work with the adoption of automation. To support their claim, the authors gathered statistical data from the United States Bureau of Labor Statistics; McKinsey Global Institute analysis, which demonstrates the labour demand for various jobs around the world. Predictable physical work and office support work are some of the few categories which are at risk of being made redundant. Furthermore, the data is also classified and broken down into its various regions. First world countries tend to implement automation due to their capability in supporting the advancement of technology. The authors go on to further discuss the importance of reskilling to

maintain a job in the workforce. Employees reskill from mundane and routine jobs, which are easily displaced by automation, to jobs which require social and emotional skills, creativity and applying high levels of cognitive function and expertise (Chui & Lund, 2018).

The Positive Impacts of Automation

The debatable question on the impacts of automation on employment has led to economists and scholars arguing their various viewpoints on the effects of automation and technology on jobs. The extent of the impacts of automation has been explored by studies through either country-industry panel settings or micro settings focused on the labour market alone, where automation is suggested to have the most effect on.

Impact on the labour market. To address the concerns of the labour market, Henrekson (2020) attests in his study that since the inception of automation, the labour market has had a positive annual net growth of 1.9 % from 1977 to 2016, suggesting that the effect of automation on the labour market has been overestimated. An article by Casey (2020) also shows, through data collected over the period of 2000 to 2015 limited to the Netherlands, that organizations which incorporated automation in their businesses saw an increase in workers employment. On the contrary, the firms that chose not to take on automation saw a decline in the number of workers in that same fifteen-year period.

Productivity and job opportunities. Jobs that encompass repetitive tasks are at risk of being taken over by automation. A study carried out by De Backer et al. (2018) projects that all jobs will have at least 30% of automation, which may be of concern for its effects on employment. Manyika et al. advocates that automation will generate new job creation and provide opportunity for low-skilled workers to reskill themselves for better job prospects. In support to that claim, another study by Vermeulen et al. (2018) shows that automation has

increased production of goods and reduced cost prices of products. The paper hence elaborates that this positive impact of automation has led to an increase in goods and products demand, expanding companies, and ultimately paving the way to the recruitment of more employees. Data collected by Ratcheva, Leopold and Zahidi (2020) shows that AI and Information Technologies (IT) related jobs are among some of the largest growing professions. This only insinuates that more individuals are accepting the need to adapt to automation and see the need to adopt technology-related professions and skills.

The Impacts of AI and Technology in Education

According to a study by Murat Gökalp (2010), the emerging threat of automation and artificial intelligence implies a great race between education and technology. The education environment consists of elements where information, knowledge and skills are transferable through the learning-teaching process where institutions and educators who are well equipped with equipment-tools and facilities that are accessible for the students who enrolled in the institutions. In some cases of most developing countries, the study mentioned that it is important to understand that education systems are not providing workers or students with the skills necessary to compete in today's job markets due to the inaccessibility of state-of-the-art academic resources (Gökalp, 2010).

The study conducted and analyzed by Murat Gökalp (2010) examines the effects of information technologies on university students in Turkey. This study would like to understand the correlation of technology to student's success. The results of the studies show the importance of the coexistence of IT and education. It is also observed that 58% of the sample size actually viewed information technologies as an important value and there is a degree of correlation between technology and students' success (Gökalp, 2010).

The impacts of technology on students' co-curriculum. It is indeed laudable that the effect of automation and AI has led to an issue of IT workers shortage. Therefore, many countries have seen the importance of computer coding and programming. Science, Technology, Engineering and Math (STEM) skills such as coding and computer programming are seen as an extremely important skill set (Meehan, 2019). Countries like Japan have made coding mandatory for primary school students in 2020. According to research by Moreno-León, Robles, & Román-González (2016), IT skill sets are known to be essential skills of the twenty-first century. The research mentioned that there is no evidence of an implementation strategy that has been established as the most effective to determine the student's success. Although the introduction of computer programming or coding in student's co-curriculum has become exponentially popular amongst countries in recent years, there is still a lack of empirical studies to conclude learning to program affects the way students decide their career or tertiary education path.

The impacts of automation on students' career decisions. On the other hand, according to Sakhumzi, Daniel, and Douglas (2019), their studies on the influence of automation on career decisions among South African students conclude an unexpected result. Although it is reported by Parschau & Hauge (2020) that many South African jobs could be lost due to automation, a study by Sakhumzi, Daniel, and Douglas (2019) on 935 South African undergraduates show that the students do not consider their own future occupations to be susceptible to automation. Hence, few of the surveyed students consider automation when deciding their career path.

Based on the studies that were done by Sakhumzi, Daniel, and Douglas (2019), the impacts of automation on student's career may vary from different regions. One of the factors that researchers highlight which impact the results of South African students deciding their

career path is the labour supply of a particular country or region. There could be a mismatch between the knowledge and skills available in the market and those employers are seeking. This mismatch of talents highlights the country's considerable shortcomings in the education system. Since the context of the studies is based in South Africa, there is an oversupply of low-skilled labour while South Africa is also experiencing an under-supply of high-skilled labour (Statistics South Africa, 2018). This small group of graduates becomes a critical economic resource as South Africa is embracing technology advancement.

Shumba and Naong (2012), as well as Dodge and Welderufael (2014), found that there are other factors that play a role in South African students deciding their career choices. These students tend to rely significantly on their personal opinions and views when making career decisions. For instance, the students consider their passions, areas of interest and assessment on their capabilities when making their career decision.

Research Question

Is automation affecting the way students decide their career or education path?

Theoretical Framework

The primary objective of this research paper is to determine the effect of automation on students deciding their education or career path. Essentially, we aim to provide students and secondarily employees with a different perspective of the ever-growing advanced society. The proposed research is vital in acting as an eyeopener for individuals of all levels, from employees and organisations to students, schools and the education system. This paper will question the need to further their skill set to ensure adaptability in the event of a change. Firstly, it is imperative that we understand, acknowledge and document the various positive and negative impacts of automation.

Key independent variable. The key independent variable in this study would be the impacts of automation. Identifying the impacts of automation will be imperative to understand the shifts in job opportunities towards the IT sectors and the need for employees to reskill and adapt to the technological advancements brought by automation. By acknowledging the impacts of automation, students are also seeing the need to adopt technological courses and electives in a bid to seek better job opportunities and pay scales. Upon gathering data on the impacts of automation, our search will be further streamlined to understand the various needs and wants of the technologically influenced robust industries. In all, this will provide students and employees with a comprehensive understanding of the possible implications of not educating or reskilling to adapt to the industries.

Independent variables. The independent variables in this study will encompass Singapore's population, its Gross Domestic Product (GDP), the employment rate in the Manufacturing sector, the employment rate in the Information and Communications sector, the employment rate of students graduating from the School of Engineering, and finally the employment rate of students graduating from the School of Computer.

Dependent variables. There are two dependent variables in this study. The first dependent variable would be the number of students enrolled in Engineering courses and the second dependent variable would be the number of students enrolled in IT related courses.

Hypotheses

The null hypothesis of the paper would be that there is no relation between the impacts of automation and how it is affecting the way students decide their career or education path. The alternate hypothesis would be that there is indeed a relation between the impacts of automation and how it is affecting the way students decide their career or education path.

Study Design

The purpose of the study conducted in this paper is to evaluate if the increasing impact of automation on the various industries influences the way students decide their career path. The paper will first closely examine the increasing impact of automation on the various job sectors and how the impact has affected these industries either positively or negatively. The paper will then determine how the impact influences tertiary students' decisions on choosing their career path or course electives for job security and opportunities. The study will encompass the examination of Singapore's employment data of various industries over the span of the last 15 years, from the year 2005 to 2019 respectively, to understand the impact of automation in different job sectors and its growing significance. In addition, the study will assess the number of tertiary students in Singapore being enrolled into technology-related courses for the past few years from 2005 to 2019, to further identify the shift in interest for learning technology due to the changing job prospects brought by automation. Hence, the research question for the paper would be "Is automation affecting the way students decide their career or education path?" The significance of the data observed will be analysed through a null and alternate hypothesis.

H0: There is no relation between the impact of automation and how it is affecting the way students decide their career or education path.

H1: There is indeed a relationship between the impact of automation and how it is affecting the way students decide their career or education path.

The data analysis methods used to examine the impact of automation on employment rate and student enrolment data will be Correlation Coefficient, T-Test and Regression Analysis. The

selected methods will be integral in determining the strength of how strong or weak the relationship is between multiple variables. The methods will also prove beneficial in better understanding the relationship between the dependent and independent variables. The chosen methods of data analysis will be further elaborated in great detail in the later stages of the paper.

Population and Sample

The study will encompass two sets of population and sample data sets; one for employment rate and one for student enrolment rate. With respect to employment rate, the population used in the study will be Singapore's employment rate in the various industries from the year 2005 to 2019. The sample size for this data set would be the varying employment rate in the Manufacturing sector where the automation is suggested to have the most negative impact on, the Community, Social and Personal services sector whereby automation has had the least significant impact on, and finally the Information and Communications sector where the automation is suggested to have the most positive impact on.

With respect to student enrolment rate, the population used in the study will be Singapore's student enrolment rate in the various government universities from the year 2005 to 2019. The sample size for this data set would be the varying enrolment rate of students in the engineering courses and the varying enrolment rate of students in the IT related courses.

Variables and Measures

The study will use the impact of automation as the key independent variable. However, there is also a need to consider the sub independent variables which would fall into this category including GDP of the various industries and population of Singapore. Identifying the impact of automation will be imperative to understand the shifts in job opportunities towards the various automation influenced sectors, such as manufacturing and construction, to name a few, and the

need for employees to reskill and adapt to the technological advancements brought by automation.

Impact of Automation

One of the ways the impact of automation can be quantified is through the employment rate of the industrial sectors. As automation increases productivity, it has an inverse relationship with the employment rate. Therefore, automation reduces the employment rate of the affected industries. In a study conducted by Mckinsey Global Institute, over 39 to 73 million jobs will be lost due to automation (BBC, 2017).

Although GDP and population are affiliated with employment rate, monitoring the various industries directly affected by automation may prove pivotal in this study. Jobs which are repetitive, straining, and time-consuming, such as the manufacturing and construction sector, are at high risk of losing jobs. To put things into perspective, based on a statistical study in Singapore, ever since 2000, the manufacturing industry has seen a drastic drop in the employment rate (Department Of Statistics Singapore, 2020). This is a possible causal factor for students to venture into other sectors.

GDP

In economics, GDP is one of the most frequently used indicators to track the health of a nation's economy (Kramer, 2020). Economists use GDP to determine if the economy is experiencing growth or a possible recession. One of the key factors to a strong economy is a low unemployment rate. As the GDP is high, companies from various industries will continue hiring. Conversely, although GDP continues to rise, with economic and financial backing, companies will be looking to stay relevant in the new industrial age of automation, especially due to the benefits it possesses. This may have a profound impact on employees.

Population of Singapore

As this study is based in Singapore, it is essential to understand the population of Singapore. Currently, Singapore is facing an increasingly ageing population, due to the increased life expectancy coupled with the decrease in birth rates (Hirschmann, 2020), the decline in birth rates and population will have an impact on the employment rate in the coming years. In return, the declining population can influence the impact of automation. The decrease in population has the potential to saturate a market. With the possibility of automation eradicating jobs, students and employees may find the need to infiltrate other up and coming markets or industries to maintain their employment status.

Dependent Variable

The dependent variable, also known as the outcome variable, is the number of students enrolling into engineering or IT related courses. The enrolment rate of students from tertiary institutes will provide clarity on their choice of career path. With the results obtained from this study, students and employees can strive towards the possibility of staying current with the advancement of automation by opening themselves to re-skilling, venture into automation-inclined industries, or pursue a different career altogether, in which automation would not be a hindrance.

Measures

The data utilised for this study is obtained and analysed from the Department of Statistics Singapore. Firstly, the impact of automation is measured by the employment rate in Singapore. This data is measured by the number of employees working in various sectors. As for GDP, the data is measured in SGD. To facilitate the ease of calculation, the manufacturing sector has been selected to represent the GDP as it is one of the most affected industries. The

population of Singapore is measured in millions, inclusive or citizens, permanent residents, and foreigners. Lastly, the dependent variable, the number of students enrolling into engineering or IT related courses, will be obtained by data sets containing enrollment and intake numbers of students in the various local tertiary education.

Data Collection Methods

This study utilizes the following data sets: employment in Singapore, as well as different types of course enrollment and employment survey from all of the autonomous universities in Singapore. The purpose of this was to try to understand which jobs could possibly be automated in the Singapore workforce, looking at not just every local workforce profession, but also the students who are the future of the industry. This would help readers to consider the pace at which certain innovations that exist today and technologies that could be introduced in the industry were theoretically, may be affecting a student's career education path. According to Hawksworth, Berriman and Goel (2018), new innovations, such as the computer and automation have effectively replaced many jobs, such as transport, financial services and health, once widespread in the 20th century. As some expected, advancements in AI and automation are highly weighted against these types of technology, the potential for massive job turnover and further erosion of labor share is extremely high. While automation and robotics will eliminate millions of jobs, it is also crucial to understand that there are new types of jobs that will be produced rather than replaced as a result of AI and robots being introduced. Innovation does not necessarily equate to the extinction of jobs, where new technology ultimately replaces workers. Technology can be a complementary force in the workplace. However, to quantify the impact of automation, we have used data on the employment residences in Singapore.

Courses	Mean	Standard Deviation	Minimum	Maximum	Sum
Accountancy	4026.8	907.3913315	2561	5226	60402
Architecture, Building & Real Estate	1776	251.2903841	1310	2020	26640
Business & Administration	6665.266667	1436.631152	5013	10028	99979
Dentistry	192.9333333	30.32317988	139	232	2894
Education	607.8	609.2867258	0	1752	9117
Engineering Sciences	16319.46667	1039.711764	14368	18132	244792
Fine & Applied Arts	1209.4	434.9996388	355	1629	18141
Health Sciences	1438.8	760.7345323	433	3107	21582
Humanities & Social Sciences	10578.33333	1937.130524	6743	13192	158675
Information Technology	4171.866667	1357.157	2356	7386	62578
Law	1383.133333	289.356149	844	1774	20747
Mass Communication	712.8666667	44.99185111	644	781	10693
Medicine	1520.333333	330.4416237	1169	2095	22805
Natural, Physical & Mathematical Sciences	7477.8	892.0172324	5389	8361	112167
Services	580.9333333	296.6709256	108	1047	8714

Table 1. Descriptive Statistics of Courses in Singapore's Autonomous University from 2005-2019

	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Sum	Count
Manufacturing	13914.29	1096.590978	13900	4103.067735	16835164.84	-1.59017	0.094011	11600	8600	20200	194800	14
Construction	3792.857	124.2402342	3700	464.86439	216098.9011	-0.01482	0.524582	1700	3000	4700	53100	14
Services	83564.29	1949.094102	81550	7292.842344	53185549.45	-0.78454	0.617205	21400	75100	96500	1169900	14
*Other Industries Nes **	1228.571	95.17397109	1250	356.1083919	126813.1868	2.156611	0.632682	1500	600	2100	17200	14

Industries listed under services
*Wholesale & Retail Trade * Transportation & Storage * Accommodation & Food Services Information & Communications Financial & Insurance Services * Business Services Real Estate Services*

Table 2. Employed Singapore Residence aged 26-29 years 2005-2018

Proposed Survey for Data Collection

On top of utilizing the data published by the Government of Singapore, we would like to propose a survey to further enhance our study in finding out if automation affects the career paths of students. The reason for this survey proposal is because there are limited studies and data collected to quantify the effects of automation and students' career decisions. The survey we are proposing consists of five statements to which respondents or students will indicate their level of agreement with regards to automation on a five-point scale ranging from Strongly Disagree (1) to Strongly Agree (5). The questionnaire for the first section consists of:

- I am aware of the capabilities that machines can perform.
- I am aware of various types of jobs or industries that can be automated.
- I am aware of the capabilities of artificial intelligence.
- I am aware of how technology affects employment levels/rates
- If the prevalence of automation has affected their choice of majors/career path

The second segment considers the level of beliefs with regards to respondents' views on job automation. These questionnaires will be utilising the similar five-point scale ranging from Strongly Disagree (1) to Strongly Agree (5). The questionnaire for the second section consists of:

- I believe that human workers will be replaced by machines.
- I believe that there are various types of jobs machines cannot perform.
- I believe that machines will soon surpass human intelligence.
- I believe that there will always be work for humans.
- I believe that the career I plan to do will soon be automated.

Hence, with the results of the questionnaire, a table of beliefs for descriptive analysis for the awareness of automation can be produced. This is to understand the mean and standard deviation of students who are “Unaware”, “Moderately Aware” and “Very Aware” of automation which may lead to their career decisions.

Students who believe that:	**Unaware**	**Moderately Aware**	**Very Aware**
	Mean (SD)	Mean (SD)	Mean (SD)
Human workers will be replaced by machines	x.xx (x.xx)	x.xx (x.xx)	x.xx (x.xx)
Various types of jobs machines cannot perform	x.xx (x.xx)	x.xx (x.xx)	x.xx (x.xx)
Machines will soon surpass human intelligence	x.xx (x.xx)	x.xx (x.xx)	x.xx (x.xx)
There will always be work for humans	x.xx (x.xx)	x.xx (x.xx)	x.xx (x.xx)
The career they plan to do will soon be automated	x.xx (x.xx)	x.xx (x.xx)	x.xx (x.xx)

Table 3. Sample table for descriptive statistics on Students beliefs on automation

Data Analysis Methods

Other than the proposed qualitative method of conducting a survey, the quantitative methods that this research report will be using to address our research question would be the Correlation Coefficient, T-test and Regression Analysis method.

Correlation Coefficient

The correlation coefficient indicates the relationship between different variables. A correlation coefficient varies from -1 to 1, where inverse correlations will be shown by negative values. Based on the descriptive statistics presented in Tables 1 and 2, this result shows the relationship between Engineering Graduates, IT Graduates, Manufacturing Industry, Construction Industry, Service Industry and Other industries. Based on the Correlation Coefficient result, there is a negative Correlation between IT Graduates and Manufacturing Industry. The correlation coefficient table shows that there is a fairly strong negative correlation (-0.6) between IT graduates and Manufacturing industry. This analysis shows that we are able to observe that there is indeed a negative correlation between IT graduates and the manufacturing industries which is known to be highly affected by automation. Another result worth mentioning is the relationship between the number of graduates in Engineering Science Course and IT. If Engineering Science Graduates increases by one unit, the IT Graduates increases by 0.4 units. This shows a positive growth between the graduates from the two courses offered by Singapore Autonomous University. According to the published data by the Government of Singapore, Engineering Science has the largest population of graduates with about 18,132 in 2018 as compared to the other 14 courses offered by Singapore Autonomous University. However, the IT Graduates were ranked fourth with about 7,386 graduates in 2018 as compared to the other 14

courses that were offered.

	Engineering Sciences Graduates	*Information Technology Graduates*	*Manufacturing Industry*	*Construction Industry*	*Services Industry*	*Other Industries Nes **
Engineering Sciences Graduates	1					
Information Technology Graduates	0.414230314	1				
Manufacturing Industry	-0.575278131	-0.854999372	1			
Construction Industry	-0.248458275	0.036457987	-0.10399222	1		
Services Industry	0.614466764	0.857489732	-0.865638635	0.199136728	1	
Other Industries Nes *	0.143360406	0.297189452	-0.537290496	0.558936166	0.550160918	1

Table 4. Correlation Coefficient between Engineering Science, Information Technology, Manufacturing Industry, Construction Industry, Service Industry and Other Industries.

The T-Test Analysis

A t-test analysis was run against Manufacturing Industry Employment and IT Graduates to test the significance of the data with the alpha being set at 5% (0.05). The result of the T-test analysis is shown as follows:

H0: There is no relation between the impact of automation and how it is affecting the way students decide their career or education path.

H1: There is indeed a relationship between the impact of automation and how it is affecting the way students decide their career or education path.

The calculated t-value is less than the table value at an alpha level of 0.05.

$$\text{T-value} = 0.00000026029135508 35 < 0.05 = \alpha$$

We will hence reject the null hypothesis that there is no relation between the impact of automation and how it is affecting the way students decide their career or education path. At the 95% level of confidence, we conclude that there is indeed a relationship between the impact of automation and how it is affecting the way students decide their career or education path.

t-Test: Two-Sample Assuming Unequal Variances		
	Manufacturing Industry	*Information Technology Graduates*
Mean	13914.28571	3942.285714
Variance	16835164.84	1132130.374
Observations	14	14
Hypothesized Mean Difference	0	
df	15	
t Stat	8.802477749	
P(T<=t) one-tail	1.30E-07	
t Critical one-tail	1.753050356	
P(T<=t) two-tail	2.60291E-07	
t Critical two-tail	2.131449546	

Table 5. T-test analysis between Manufacturing Industry Employment and Information Technology Graduates

Regression Analysis

One of the proposed analyses of this study involves the regression analysis method, which is mainly used to predict the relationship between the dependent variable and the independent variables. In the study, the key independent variable is identified as the impact of automation and the other independent variables include the GDP and population of Singapore, while the dependent variable is addressed as the number of students enrolling into engineering or IT related courses. Hence, with the use of regression analysis, the study will be able to link the influence of the independent variables on the dependent variable.

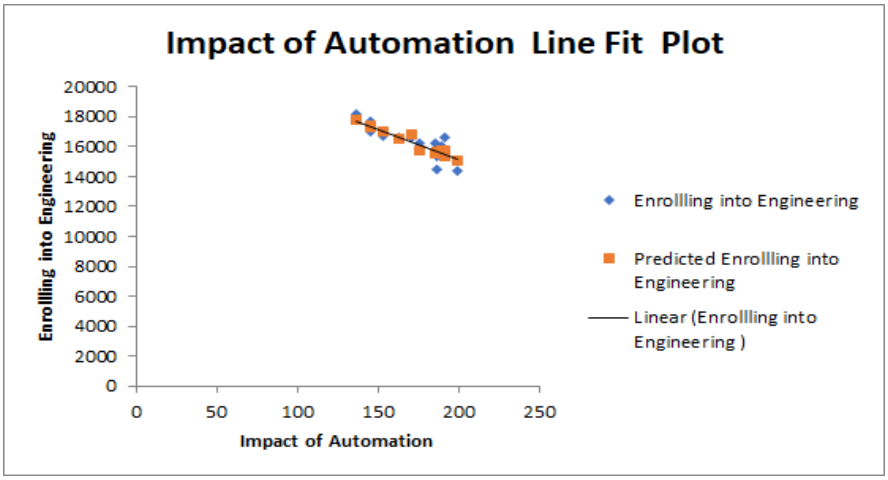
The graphs illustrated below are a representation of our observation on the relationship between the X and Y-axis. The X-axis represents the independent variables, such as the impact of automation, GDP, and population. The Y-axis represents the dependent variables, such as the enrolment of students into IT or engineering courses. In doing so, this will aid in representing the relationship between the dependent and independent variable. To find the regression we must use the following equation:

$$y = \alpha + \beta 1 \text{ Impact of Automation } + \beta 2 \text{ GDP } + \beta 3 \text{ Population } + \varepsilon$$

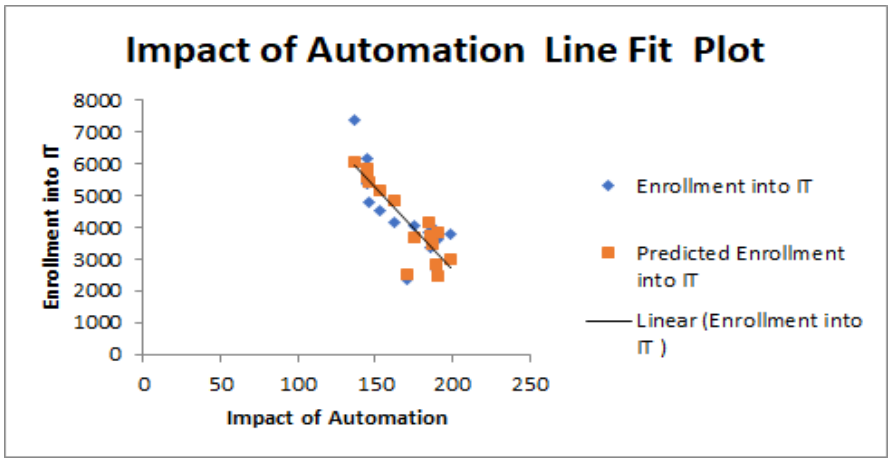
y = Students Enrolling into Engineering or IT related courses (dependent variable)

β = Coefficient (measures the size of the impact of the independent variable)

Ɛ = Error



Graph 1. Enrollment of Students into Engineering Courses Against the Impact of Automation



Graph 2. Enrollment of Students into IT Courses Against the Impact of Automation

Based on Graph 1 on the enrollment into engineering courses, the impact of automation, measured by the employment rate of the manufacturing industry, has an inverse relationship with the number of students joining Engineering courses. Comparatively, there is a similarity between both the dependent variables, students enrolling into both Engineering and IT courses, pertinent to the independent variable of the impact of automation. There is a negative trendline associated

with the two variables. As illustrated in Graph 2, with the impact of automation continuing to affect the employment rate, students are looking to penetrate the booming industries to stay relevant to automation, such as Engineering and IT.

Regression Statistics	
Multiple R	0.863626717
R Square	0.745851107
Adjusted R Square	0.676537773
Standard Error	591.3229628
Observations	15

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	27630.15395	4324.147763	6.389733994	5.15319E-05
Impact of Automation	-48.91760364	12.11050313	-4.039270964	0.001950904
GDP	3.86769E-06	8.66666E-06	0.446272166	0.664057973
Population	-0.000620108	0.000479472	-1.29331392	0.222402653

Table 6. Regression Analysis of the number of students enrolling into engineering

Interpreting from Table 6, the impact of automation has an inverse relationship with the enrollment of students into engineering courses. As the impact of automation is the employment rate, the decrease in employment rate, theoretically refers to the increase in the impact of automation. Resulting in an increment in the enrollment of students into engineering courses. This is an expected result, in which it goes to show that there is a possibility that the students are acknowledging the lowered employment rate, therefore, joining engineering-related courses

which enable students to stay relevant and current within the industry. Moving on, this set of data is rather statistically significant as the P-Value is less than 0.05 at 0.00195. Although there are positive and negative relationships between both GDP and population respectively, the P-Value concludes that these variables are not statistically significant for the students enrolling into engineering courses. Lastly, as the adjusted R Square is at 0.677, this model is a good representation.

Regression Statistics	
Multiple R	0.905629928
R Square	0.820165567
Adjusted R Square	0.771119813
Standard Error	649.283238
Observations	15

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-2301.530364	4747.99194	-0.484737631	0.63737096
Impacts of Automation	-17.26749111	13.29755003	-1.298546805	0.220662525
GDP	1.26661E-05	9.51615E-06	1.331013183	0.210113896
Population	0.00165357	0.000526469	3.14086691	0.009393875

Table 7. Regression Analysis of the number of students enrolling into IT

Comprehending Table 7, the impact of automation has a negative impact on the students enrolling into IT related courses. This suggests that as employment is going down, students

venturing into IT courses are increasing. Another statistically significant variable would include the population variable. Holding a P-Value of 0.0094 suggests that there is a positive relationship between the population of Singapore and the number of students enrolling into IT courses. Finally, as the adjusted R Square is at 0.771, this model is of good-fit and hence it is an accurate representation.

Limitations

As with the majority of studies, these results must be interpreted with caution and a number of limitations should be borne in mind. Firstly, as our research is theoretically based upon the future, though some of the data procured and analysed included past and current statistics, we can only obtain possible predictions. However, predictions are not necessarily as accurate as it always is. Therefore, this has become one of the limitations of our study.

The second limitation is the lack of previous research studies on the topic. After conducting preliminary research on the selected topic, there was minimal research found between the impact of automation and students deciding their career paths. There were many inferences that had to be drawn to link the research topic. However, this hinders the credibility and scope of the research. Hence, there is a need for future research to be conducted on this topic.

Finally, although we managed to interpret the data, there were time constraints, which impeded and limited our access to data. The inclusion of several more variables would enhance the analysis provided. However, with limited time available, searching and procuring other data sets seemed challenging. Hence, the omission of certain variables, which might have an impact on our research.

Recommendations

The next wave of digital technologies resembles previous industrial revolutions, and historical experience suggests that market dynamics will naturally evolve. However, it is also important for government policy to take place to prepare its citizens for the uncertainties of automation in the near future. With countries and organisations adopting automation, there is a need to implement a policy or practice to support employees affected by automation. By providing courses and subsidiaries, such as SkillsFuture, will encourage employees to reskill and improve their hard and soft skills to ensure relevance in the respective industries.

The Ministry of Education (MOE) needs to impose an educational policy, which mandates students to learn and adapt to automation by harnessing IT related skills through obligatory IT-related electives during their course of study. Introducing courses such as coding, design and technology in the elementary level will provide students with the head start they require to venture into the myriad of technologically advanced industries. Not only does it provide a head start, but also prepare students for the inevitable by learning IT-related modules.

Conclusion

In conclusion, the impact of automation might play a role in students choosing their career path. At this point in time, there is some missing evidence and studies to provide a definitive answer to this question. However, there is a strong agreement between the scholars and the industry leaders which requires employees and students from the wider sector of the industry to understand that artificial intelligence and machine learning will disrupt the status quo to increase work efficiency. Therefore, we believe that educators, researchers and industry leaders will have a vital role to play to communicate the implication for the labour market to prospective

students and future job seekers in order to prepare them for the next wave of the industrial revolution.

References

Acemoglu, D., & Restrepo, P. (2019). Automation and New Tasks: How Technology Displaces and Reinstates Labor. *Journal Of Economic Perspectives, 33*(2), 3-30. https://doi.org/10.1257/jep.33.2.3

BBC. (2017). *Robot automation will 'take 800 million jobs by 2030' - report*. BBC News. https://www.bbc.com/news/world-us-canada-42170100

Casey, M. (2020). Automation and labor market institutions. https://www.brookings.edu/blog/up-front/2020/01/14/automation-and-labor-market-institutions/

Chui, M., & Lund, S. (2018). How will automation affect jobs, skills, and wages? McKinsey & Company.https://www.mckinsey.com/featured-insights/future-of-work/how-will-automation-affect-jobs-skills-and-wages.

De Backer, Koen; DeStefano, Timothy; Menon, Carlo; Suh, Jung Ran (2018): Industrial Robotics and the Global Organisation of Production. In: OECD Science, Technology and Industry Working Papers, 2018/03, OECD Publishing, Paris.

Department Of Statistics Singapore. (2020). *Singapore Department Of Statistics | SingStat Table Builder - Variables/Time Period Selection*. Tablebuilder.singstat.gov.sg. https://www.tablebuilder.singstat.gov.sg/publicfacing/createDataTable.action?refId=14558.

Emily Ann Dodge and Martha Welderufael. (2014). Factors that Influence Career Choice in South African Township High School Students. Ph.D. Dissertation. University of California.

Gökalp, M. (2010). A study on the effects of information technologies on university students. *Procedia - Social and Behavioral Sciences*, *9*, 501-506. doi: 10.1016/j.sbspro.2010.12.187

Hawksworth, J., Berriman, R., & Goel, S. (2018). Will robots really steal our jobs? An international analysis of the potential long-term impact of automation. PricewaterhouseCoopers, http://pwc. co. uk/economics, access, 13.

Henrekson, M. (2020). How labor market institutions affect job creation and productivity growth. *IZA World of Labor*. doi: 10.15185/izawol.38.v2

Hirschmann, R. (2020). *Topic: Aging population of Singapore*. Statista. https://www.statista.com/topics/5821/ageing-population-of-singapore/

Kramer, L. (2020). *What Is GDP and Why Is It So Important to Economists and Investors?* Investopedia. https://www.investopedia.com/ask/answers/what-is-gdp-why-its-important-to-economists-investors/.

Manyika, J., Chui, M., Miremadi, M., Bughin, J., George, K., Willmott, P., & Dewhurst, M. (2020). A Future That Works: Automation, Employment, and Productivity. https://www.mckinsey.com/~/media/mckinsey/featured%20insights/digital%20disruption/harnessing%20automation%20for%20a%20future%20that%20works/a-future-that-works-executive-summary-mgi-january-2017.ashx

Meehan, Sinead. (2019). The Effects of Coding Integration on Student Engagement and Academic Achievement in a 5th Grade Mathematics Class. https://sophia.stkate.edu/maed/291

Ministry Of Education. (2020). Universities - Intake, Enrolment and Graduates by Course. https://data.gov.sg/dataset?q=Graduates

Moreno-León, J., Robles, G., & Román-González, M. (2016). Code to learn: Where does it belong in the K-12 curriculum? *Journal of Information Technology Education: Research, 15*, 283-303. http://www.informingscience.org/Publications/3521

Parschau, C., & Hauge, J. (2020). Is automation stealing manufacturing jobs? Evidence from South Africa's apparel industry. *Geoforum, 115*, 120-131. doi: 10.1016/j.geoforum.2020.07.002

Productivity Inc. (n.d.). Benefits of Automation | Robotic Manufacturing Automation, Robotics & Automation Solutions. https://www.productivity.com/benefits-of-automation/.

Ratcheva, V., Leopold, A., & Zahidi, S. (2020). Jobs of Tomorrow: Mapping Opportunity in the New Economy. http://www3.weforum.org/docs/WEF_Jobs_of_Tomorrow_2020.pdf

Sakhumzi N. Mbilini, Daniel B. le Roux, and Douglas A. Parry. 2019. Does automation influence career decisions among South African students? In Proceedings of the South African Institute of Computer Scientists and Information Technologists 2019 (SAICSIT

'19). *Association for Computing Machinery*, New York, NY, USA, Article 28, 1–10. https://doi.org/10.1145/3351108.3351137

Shumba, A., & Naong, P. (2012). Factors Influencing Students' Career Choice and Aspirations in South Africa. *Journal of Social Sciences 33*(2). https://doi.org/10.1080/09718923.2012.11893096

Statistics South Africa. (2018). Quarterly Labour Force Survey. Technical Report. Statistics South Africa. 1–126 pages.

Vermeulen, B., Kesselhut, J., Pyka, A., & Saviotti, P. (2018). The Impact of Automation on Employment: Just the Usual Structural Change? *Sustainability*, *10*(5). doi: 10.3390/su10051661